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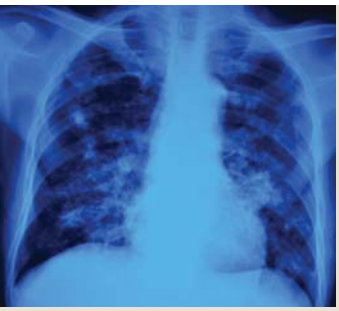

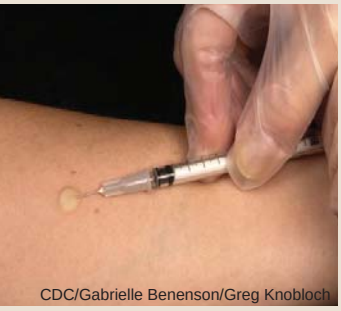

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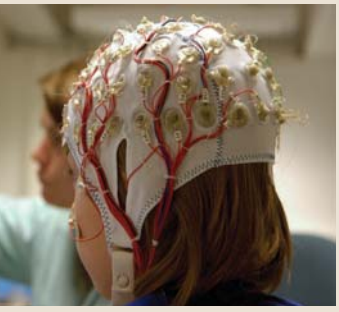

Editorial

Can the Active Component U.S. Military Achieve Tuberculosis Elimination?

James D. Mancuso, MD, MPH, DrPH (LTC, USA); Naomi E. Aronson, MD (COL[Ret], USA); Lisa W. Keep, MD, MPH (COL[Ret], USA)

Brown's law: "As a program for the control of a disease approaches the end point, meaning eradication, it is not the disease but the program that is the more likely to be eradicated."

William Brown, TIME 1962. Medicine: resurgent syphilis: it can be eradicated.

The rate of tuberculosis (TB) disease in the active component United States (U.S.) military, 0.6 per 100,000 population, is very close to the Centers for Disease Control and Prevention's (CDC's) goal for TB elimination, defined as less than one per million.[1-3] Although this goal may be unattainable for several decades due to changes in the epidemiology of the disease and fiscal restrictions on control programs, a resurgence of TB in the U.S. military can be avoided through the implementation of an efficient, high quality program to control TB infection and disease. To achieve this goal, the articles in this month's *MSMR* suggest that emphasis should be placed on: 1) targeted testing for latent TB infection (LTBI), particularly at the time of accession into military service, and 2) genotyping all cases of TB disease to further inform epidemiology and control efforts.[4,5]

After a period of neglect and cuts in funding for TB control programs in the U.S. during the 1970s and 1980s,[1-3] increased resources and infrastructure were dedicated to TB control. Since then, record lows in TB incidence and mortality have been reported, with a U.S. rate of 3.2 per 100,000 population in 2012.[6,7] Although TB elimination has been the goal of the TB control program in the U.S. since 1989, it is estimated that this will not be achieved until the year 2107 at the current rate of decline.[8] This forecast is the result of several specific challenges to elimination, including "tide pools" of increased TB incidence among foreign-born persons, racial and ethnic minorities, and other high-risk groups,[9] as well as the erosion of public health infrastructure and loss of expertise.[6,8]

As highlighted in the two TB reports in this month's edition of the *MSMR*, TB epidemiology in the U.S. military shares similar characteristics with the general U.S. population.[4,5] In both populations, rates of TB are low and continue to decline. More than half of the cases occur among foreign born and racial and ethnic minority populations. Reactivation of latent TB infection is the most common cause of TB disease; in particular, it seems more common than disease from recent transmission. Awareness of the risk factors, symptoms, diagnostic approaches, and treatment of LTBI and TB disease continue to be critical to TB elimination efforts.

However, the epidemiology of TB in the military has some unique characteristics. The lower rate of TB disease in the U.S. military is largely due to the relatively younger average age of service members, compared to adults in the general U.S. population, and to the "healthy soldier" effect. Low-incidence populations are known to pose a special risk of increased transmission and outbreaks because of the erosion of public health infrastructure and loss of expertise that can result in delays in diagnosis and incomplete follow-up.[10,11] Such outbreaks have already been seen in the U.S. military.[12] The U.S. military also has a mobile and geographically-dispersed patient population and has a relatively junior, less experienced clinical and public health staff with frequent turnover. Due

to the infrequency of TB diagnosis, many staff members have little to no experience with TB disease management. These factors increase the likelihood of delays in TB diagnosis, as was seen in the reports in this month's *MSMR*, as well as the likelihood of failures in aspects of case management (which were not seen). Additionally, military populations encounter challenges not present in civilian populations. The U.S. military frequently engages in deployments and other military service in TB-endemic countries such as Korea, Iraq, and Afghanistan. Service members may be put into close contact with TB-infected individuals during residence in congregate settings such as military barracks in basic military training, on board Navy ships, and while living with host nation personnel in embedded training or counterinsurgency teams. At the same time, high stress environments have been associated with decrements in immune function, potentially making U.S. combat forces more susceptible when exposed.[13] Despite these challenges, TB control indicators in the military were quite good in 2011 compared to U.S. averages and goals.

As is true for the civilian U.S. population, the elimination of TB will not occur in the U.S. military until it is controlled among the foreign born and other high risk groups. The reports in this month's *MSMR* suggest that efforts at better targeting and treating LTBI at the time of entry into service are warranted, with emphasis on improving the initiation and completion of LTBI therapy among these high risk individuals. Delays in diagnosis of TB disease can be reduced by adding the use of modern diagnostic tools such as nucleic acid amplification testing (NAAT) to standard diagnostic tests (acid fast smear and culture) of respiratory samples.[14] Additionally, understanding the epidemiology and transmission patterns of TB disease in low incidence populations is important in order to avoid increased transmission and resultant outbreaks. Surveillance is therefore a critical component of successful TB control, providing information necessary to target prevention efforts; to inform control measures, policies, and program evaluation; and to measure progress towards TB elimination.[15] One important element in improving surveillance is the use of isolate genotyping, which evaluates the DNA of *Mycobacterium tuberculosis* isolates to show specific genetic patterns. Genotyping can detect genetic relationships between the TB bacteria of recently transmitted cases to identify outbreaks and can differentiate reactivation of infection existing prior to military service from infection acquired during service. This type of information will allow better targeting of control and prevention efforts by identifying high-risk settings for TB transmission and using this information to mitigate that risk.[16]

Finally, the U.S. military must ensure a sustained public health and laboratory force capable of effective TB program activities. Decreased program funding has been associated with TB resurgence and worsening TB program indicators.[6] Fortunately, most of the indicators reported in this month's *MSMR* were good, with only a few concerning areas such as delayed time to treatment and the 2009 increase in TB cases associated with deployments to Iraq. Nevertheless, the U.S. military must continue to mitigate unique military exposures and risks associated with TB, or it will remain vulnerable to the risk of TB resurgence among military service members and veterans. While some reductions in infrastructure and resources may be necessary during difficult financial times, we must be aware of Brown's law, taking care not to eliminate TB control programs rather than eliminate the disease itself. Targeting TB control efforts, rather than eliminating them, will result in increased efficiency and effectiveness, while still reducing the threat of TB resurgence.

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Tuberculosis Trends in the U.S. Armed Forces, Active Component, 1998-2012

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Members of the Armed Forces represent a segment of the U.S. population that may be at increased risk for tuberculosis (TB) infection, disease, and transmission due to overseas service in endemic areas and residence in congregate settings. The purpose of this study was to examine recent surveillance trends and risk factors associated with TB disease in the active component U.S. military. The rate of TB in the U.S. military - 0.6 per 100,000 population (n=128) over the interval from 1998 to 2012 - was lower than the age-adjusted rate among the U.S. population (adjusted rate ratio=0.20) over the same time interval. During the last five years of the surveillance period, the most common factor associated with the diagnosis of TB disease during military service was latent infection at time of accession; also, as many as nine (24%) cases of TB were associated with deployment to Iraq or other military exposures. TB control activities should continue to mitigate unique military exposures such as crowding during recruit training and deployments to TB endemic areas.

Tuberculosis (TB) is a well-recognized public health problem in the United States (U.S.). In 2012, there were 9,951 reported cases of TB in the U.S. (rate: 3.2 per 100,000 population).[1] Although the incidence rate of TB is relatively low, it is unlikely that the U.S. will meet its goal of eliminating TB (defined as a rate of less than one per one million population) in the foreseeable future.[2,3] To speed the decline of TB in the U.S., increased attention has been directed to populations at higher risk of TB infection and progression to active disease.[4] Foreign-born persons and certain racial and ethnic groups account for increasingly larger proportions of cases in the U.S.; in 2012, 63 percent of TB cases occurred among foreign-born persons.[1]

Military service members may be at increased risk for TB infection and transmission due to service in TB endemic areas overseas and residence in congregate settings (e.g., barracks). As such, surveillance of TB among U.S. military forces has been conducted since World War I. After World War II, rates of TB disease declined rapidly in both U.S. civilian and military populations;[5,6] and during the 1980s and 1990s, incidence rates of TB disease were low and further declining in U.S. military populations.[7-9]

In recent years, military leaders have been concerned regarding TB exposures of U.S. military members during deployments to TB endemic areas of Iraq and Afghanistan.[10,11] However, from 2004 to 2006, there was no increase in reports of TB disease among military members[12] and no apparent association between TB diagnosis and deployment to Iraq or Afghanistan.[13] The purpose of this study was to examine a recent 15 year period to assess trends and risk factors associated with TB disease in the generally low-incidence population of the active component U.S. military.

METHODS

This was a descriptive study of population-based surveillance data for cases of confirmed TB disease among active component U.S. military service members from 1998 to 2012. Institutional Review Board approval was obtained from the Walter Reed Army Institute of Research (WRAIR). Reportable medical events (RMEs) among U.S. military service members and other beneficiaries are reported through the Services' surveillance centers to the Armed Forces Health Surveillance Center (AFHSC), from which relatively complete data were available starting in 1998.[14] The AFHSC provided the data from the administrative databases of the Defense Medical Surveillance System (DMSS), including reported cases of TB, demographics, and other military characteristics. Independent variables analyzed in this study included foreign birth, age, sex, racial/ethnic group, service, rank, HIV status, occupation, and length of service. Additional data were collected for the cases from 2008 to 2012 via extensive chart review of the electronic medical records of each patient using the Armed Forces Health Longitudinal Technology Application (AHLTA). The electronic medical records included outpatient medical encounters, tuberculin skin test (TST) results, laboratory and radiology reports, post-deployment health assessments, and other medical information. Results of laboratory cultures for TB during 2004 to 2012 were obtained from electronic medical records.

Cases were identified from records of reportable medical events for all types of TB disease (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] diagnosis codes 010-018) among all active component military service members from 1998 to 2012 **(Table 1)**. ICD-9-CM code 795.5, "nonspecific

reaction to TST without active tuberculosis," was specifically excluded because it indicates a diagnosis of latent tuberculosis infection (LTBI). Although only pulmonary TB is reportable in the U.S. military,[14] extrapulmonary cases were included in the analysis if reported.

Cases were reported to AFHSC as either "laboratory-confirmed" or "probable."[14] Cases were reported to AFHSC as "laboratory-confirmed" if they met at least one of the following criteria: 1) isolation of *M. tuberculosis* from a clinical specimen; or 2) demonstration of *M. tuberculosis* complex from a clinical specimen by nucleic acid amplification test (NAAT). Cases were reported to AFHSC as "probable" if they had clinical signs and symptoms of pulmonary TB with demonstration of acid-fast bacilli in a specimen when a culture had not or could not be obtained. Because both laboratory-confirmed and probable cases are considered laboratory-confirmed by Centers for Disease Control and Prevention (CDC) criteria,[1] both categories of cases were considered "confirmed" for this report.

For the period from 2008 to 2012, cases were also verified through review of electronic medical records using CDC criteria, which includes the additional category of "clinically-confirmed" cases.[1] Cases were considered "clinically-confirmed" if they did not meet the criteria for laboratory confirmation but met all of the following clinical case criteria: a positive tuberculin skin test result or interferon gamma release assay for *M. tuberculosis*; other signs and symptoms compatible with active disease; treatment with two or more anti-TB drugs; and a completed diagnostic evaluation.[1] Examinations of records prior to 2008 were not feasible because available records were incomplete.

The population at risk was estimated using the mid-year population of active component U.S. military service members (obtained from the Defense Manpower Data Center). Incidence rates were calculated as the total number of cases identified divided by the total population at risk. All statistical analyses were conducted using Stata® 11.1 (StataCorp, College Station, TX). Statistical differences were considered significant if $p<0.05$ using a two-tailed test. Rate ratios and 95% confidence intervals were calculated using Poisson regression models. Direct standardization was performed to compare age-adjusted rates of TB disease between U.S. military and civilian populations, using the U.S. military population for each year as the standard population.[15]

TABLE 1. ICD-9-CM diagnostic codes for active tuberculosis cases, U.S. Armed Forces, 1998-2012

ICD-9-CM (Diagnosis)	Reported (%)
Pulmonary	119 (93.0)
010 (Primary TB)	2 (1.6)
011 (TB of lung)	113 (88.3)
012 (Other respiratory TB)	3 (2.3)
018 (Miliary TB)	1 (0.8)
Extrapulmonary	9 (7.0)
013 (TB meningitis)	1 (0.8)
014 (TB peritonitis)	0
015 (TB of bone)	3 (2.3)
016 (TB of genitourinary system)	0
017 (TB of other organ)	5 (3.9)
Total	128 (100.0)

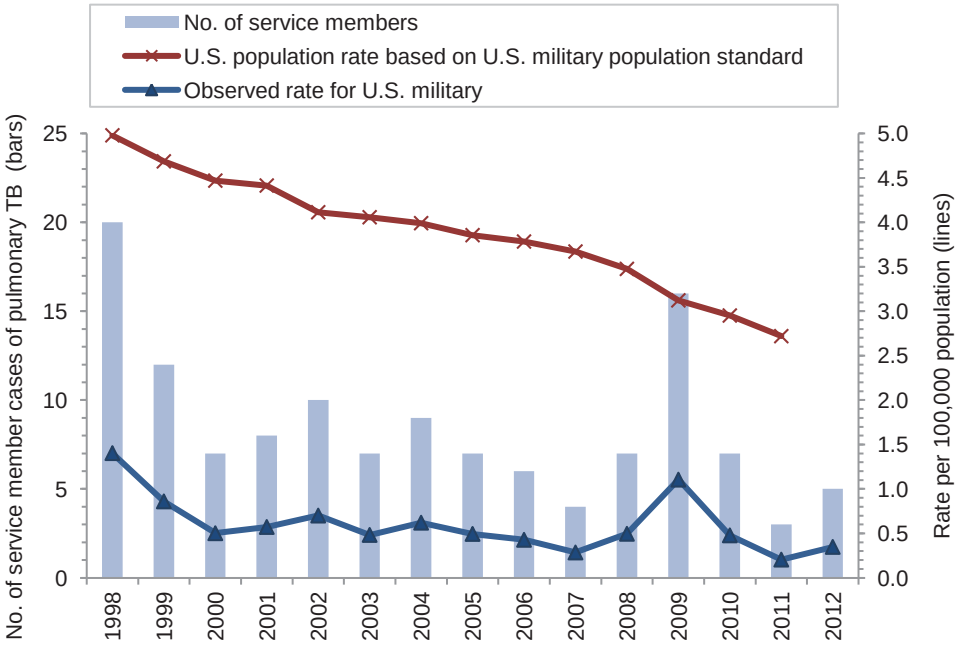
RESULTS

During the period from 1998 to 2012, there were 128 cases of confirmed TB disease. Most of the cases (93.0%) were pulmonary TB; nine (7.0%) of the reported cases were extrapulmonary TB **(Table 1)**. No service members diagnosed with TB were co-infected with HIV.

In both the U.S. general and military populations, rates declined from 1998 to 2011; the decreasing trends in both populations were statistically significant ($p<0.001$) **(data not shown)**. However, rates were consistently lower in the U.S. military than civilian population. During the surveillance period overall, the age-adjusted rate among U.S. military members was approximately one-fifth the rate among their civilian counterparts (95% CI: 0.17, 0.24) **(Figure 1)**.

During the period, annual rates of confirmed cases decreased by 75 percent (annual rates, by year: 1998, 1.40 per 100,000 population; 2012, 0.35 per 100,000 population). There were no apparent increases in TB diagnoses after the initiations of conflicts in Afghanistan in 2001

FIGURE 1. Numbers of cases and rates of pulmonary tuberculosis (TB), active component, U.S. Armed Forces, and expected age-adjusted rates of pulmonary tuberculosis in the general U.S. population, based on U.S. military population standard, 1998-2012[a]



[a]Data not available from the CDC in 2012

and Iraq in 2003. Of note, from 2008 to 2009, the incidence rate of TB diagnoses in the U.S. military doubled; the 16 cases diagnosed in 2009 were the most cases in any year since 1998.

The incidence rate overall among Asian/Pacific Islanders (5.12 per 100,000 population) was more than five times that of members of other racial/ethnic groups. Compared to their respective counterparts, rates of TB were highest among service members who were the youngest (<20 years), in the Army and Navy, in junior enlisted grades, and in "other" occupational categories **(Table 2)**. (Rates of TB among foreign born service members and those who deployed overseas were not calculated because the populations at risk could not be accurately defined).

Culture results were available for 63 (of the 64) cases diagnosed from 2004 to 2012. Of these, 59 (93.7%) were culture positive, and four were culture negative but reported as clinically-confirmed. Of the 59 culture positive cases, 56 (94.9%) had drug susceptibility data available. Two cases (3.6%) were resistant to isoniazid, one (1.8%) was resistant to rifampin, and one (1.8%) was resistant to streptomycin. No cases were resistant to pyrazinamide or ethambutol, and none were multi-drug resistant (MDR-TB) **(data not shown)**.

Thirty-eight cases diagnosed from 2008 to 2012 were further assessed by electronic chart reviews. Cavitary lesions were documented in the records of 15 (39.5%) of the 38 cases. Of 36 cases with documented sputum smear results, 16 (44.4%) were smear positive **(Table 1)**. Also, of the 38 cases, 17 (44.7%) were born outside the contiguous U.S.: Philippines (n=6); Pacific Islands (n=3); Puerto Rico, Kenya, Cameroon, Mexico, Thailand, Ivory Coast, Peru, and Haiti (1 each). Twelve (31.6%) of the cases had been assigned overseas prior to their TB diagnoses: Germany (n=4); Hawaii (n=3); Japan (n=2); Turkey, Alaska, and England (1 each) **(data not shown)**; and 17 (44.7%) of the cases had been deployed outside the U.S. prior to their TB diagnoses: Iraq (n=11); shipboard (n=3); Afghanistan (n=2); and Kuwait (n=1).

The medical records of each case were reviewed to determine the most likely sources of their infections based on temporality and risk factors. The most common factor associated with active TB was LTBI at the time of accession to military service (as evidenced by positive TST reactions). Twenty-two cases (57.9% of the total) had evidence of LTBI at the time of accession to service; and of these, 8 (21.1% of the total) had TB disease diagnosed at the time of entry to service. Of the remaining 14 with LTBI at accession, 7 (18.4% total) were never treated, and 7 others (18.4% total) were reported as treated prior to their accessions to or during service **(Table 3)**. Available records were insufficient to verify whether treatments were fully completed.

Of the 16 (42.1% total) cases with no evidence of TB infection at their times of accession, 2 were reportedly exposed to cases of TB disease (one military contact and one non-military contact) while in military service. Nine (23.7% total) cases had TB diagnosed subsequent to deployment or other overseas service: 7 in Iraq (2 of these had additional exposures in Japan or Turkey), 1 in Afghanistan, and 1 in Japan. Four (10.5% total) cases had no known military exposures but had risk factors existing prior to accession; and 1 case had no known exposures or identifiable risk factors before or during military service **(Table 3)**. Finally, 11 (28.9% total) cases were identified within 1 year of accession, 19 (50.0% total) within 1-4 years, and 8 (21.1% total) had been in service for more than 4 years before their TB diagnoses.

TABLE 2. Incidence of active tuberculosis by demographic and military characteristics, active component, U.S. Armed Forces, 1998-2012

	No. of cases	Rate[a]	Rate ratio (95% CI)
Sex			
Male	109	0.60	Ref
Female	19	0.62	1.03 (0.60, 1.69)
Race/ethnicity			
White, non-Hispanic	32	0.24	Ref
Black, non-Hispanic	34	0.91	3.85 (2.30, 6.44)
Asian/Pacific Islander	42	5.12	21.57 (13.3, 35.3)
Hispanic	16	0.76	3.18 (1.63, 5.97)
American Indian/Alaskan Native	2	0.80	3.37 (0.39, 13.2)
Other	0	0.00	0.00 (0, 3.88)
Unknown	2	0.34	1.45 (0.17, 5.68)
Age			
<20	19	1.30	1.89 (1.05, 3.29)
20-24	48	0.68	Ref
25-29	22	0.47	0.69 (0.39, 1.16)
30-34	14	0.44	0.64 (0.33, 1.18)
35-40	12	0.43	0.64 (0.31, 1.22)
40+	13	0.58	0.84 (0.42, 1.59)
Service			
Army	60	0.79	Ref
Navy	39	0.74	0.94 (0.61, 1.43)
Air Force	16	0.31	0.39 (0.21, 0.68)
Marines	12	0.44	0.55 (0.27, 1.04)
Coast Guard	1	0.17	0.21 (0.01, 1.26)
Rank			
Junior enlisted (E0-E4)	76	0.82	Ref
Senior enlisted (E5-E9)	43	0.50	0.62 (0.45, 0.83)
Officer/Warrant (O1-O9, W1-W5)	9	0.25	0.31 (0.14, 0.59)
Military occupation			
Combat arms	13	0.35	Ref
Healthcare	8	0.46	1.28 (0.46, 3.34)
Special operations	1	0.13	0.37 (0.01, 2.47)
Military police	2	0.40	1.13 (0.12, 4.99)
Other	104	0.71	1.99 (1.12, 3.87)

[a]Rate per 100,000 population

TABLE 3. Factors associated with active tuberculosis (TB) cases, active component, U.S. Armed Forces, 2008-2012

	No. cases (% total)		
Total	38 (100.0)		
TST positive at accession	22 (57.9)		
Active TB identified		8 (21.1)	
Latent TB identified		14 (36.8)	
Untreated			7 (18.4)
Treated prior to accession			4 (10.5)
Treated after accession			3 (7.9)
TST negative at accession	16 (42.1)		
Known contact with an active TB case during service		2 (5.3)	
Military active TB contact			1 (2.6)
Non-military active TB contact			1 (2.6)
Deployment or overseas service-associated transmission[a]		9 (23.7)	
Iraq[b]			7 (18.4)
Afghanistan			1 (2.6)
Japan[c]			2 (5.3)
Turkey[d]			1 (2.6)
No known exposure, but risk factors present prior to accession		4 (10.5)	
Foreign born			2 (5.3)
Former intravenous drug user			1 (2.6)
Contact with active TB case prior to accession			1 (2.6)
No known exposures or potential risk factors		1 (2.6)	

[a]Includes only deployments or service which occurred before TB diagnosis
[b]Two of these cases also had non-deployment overseas service: Japan (1) and Turkey (1)
[c]One of these cases also had service in Iraq
[d]This case also had service in Iraq

EDITORIAL COMMENT

This report documents that the rate of TB disease in the U.S. military – 0.6 per 100,000 over the interval from 1998 to 2012 – was lower than the age-adjusted rate among the U.S. population (adjusted rate ratio=0.20) over the same time period. The rate among U.S. military members during the period meets the national goal (rate less than 1.0 per 100,000 population) as promulgated in Healthy People 2020.[16]

The correlates of risk for TB among U.S. military members as documented here are similar to those among members of the U.S. general population; these include foreign birth and Asian/Pacific Islander race/ethnicity.[17,18] Latent tuberculosis infection at the time of accession to service was the most common factor associated with the diagnosis of TB disease during military service. Of note, several cases had histories of recent deployments to Iraq and/or other military overseas assignments.

There are several limitations that should be considered when interpreting the results of this report. TB cases may be incompletely ascertained because only laboratory-confirmed cases are reportable to the military's notifiable medical event surveillance systems. Also, the U.S. military reporting guidelines specify that pulmonary, but not extra-pulmonary, TB cases are reportable;[14] as such, extra-pulmonary TB may have been underreported. There is also possible confounding from demographic differences between the services.[5] In addition, cases for this report may have been incompletely ascertained because of incomplete or inaccurate reporting (e.g., from overseas locations, care outside the military health system) and discharge from military service prior to the development or diagnosis of TB disease, although the number of these cases is expected to be small.

Finally, readers should note that percentage decrease in annual numbers and rates of TB cases from 1998 through 2012 was affected by an outbreak of TB on the *U.S.S. Wasp* in 1998, the baseline year to which 2012 was compared.[19]

A potentially important finding of this report is that the majority of TB disease cases (57.9%) diagnosed from 2008 to 2012 were associated with LTBI at the time of accession of the affected service members. The finding supports continued emphasis on targeting high-risk groups for treatment of LTBI,[20] particularly at entry into service.[21] Also, since several cases were diagnosed among military members who reportedly had been treated, service members who report LTBI treatments prior to service should present written medical documentation of the natures and completion of such treatments; also, those who are treated while in military service should be monitored to ensure completion of therapy.

Although TB disease initially continued to decline in the U.S. military despite large-scale operations in the TB-endemic countries of Afghanistan (beginning in 2001) and Iraq (beginning in 2003), this report describes an increase in cases during the years 2008 to 2010. Furthermore, up to nine (23.7%) cases diagnosed between 2008 and 2012 were associated with prior deployments or other military service. Although a previous analysis showed no association between deployment and TB disease during the period between 1990 and 2006,[13] changes in the nature of the conflicts may have increased the risk of transmission in subsequent years. Specifically, counter-insurgency strategies that increase interactions between U.S. military members and host nation populations may also increase TB exposure risk. Other factors that may have contributed to an increase in diagnosed cases in recent years include better recognition of TB disease, improvements in case reporting, and increases in TB testing before and after deployments. Of note, a previously reported association between TB and prior service in Korea[13] was not seen in this analysis. Continuous, high quality TB surveillance is an important method in the control of TB in the U.S. military; such surveillance enables the detection and characterization of ongoing transmission, assessments of the effects of ongoing control efforts, and targeting and tailoring of new or modified prevention policies and practices.

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Using the Tuberculosis Cohort Review to Evaluate and Improve the U.S. Army's Tuberculosis Control Program

Christopher L. Aaron, DO (CPT, USA); James D. Mancuso, MD, MPH, DrPH (LTC, USA)

The challenges of tuberculosis (TB) control in the U.S. military are similar to those in other low-incidence populations; in addition, the U.S. Military Health System must account for geographic separation, frequent staff turnover, deployments to TB-endemic areas, and residence in congregate settings. The objective of this evaluation was to use a TB cohort review process to assess indicators of the quality and effectiveness of the TB control program in the U.S. Army. Ten cases of TB disease occurred at U.S. Army installations in 2011; all were pulmonary. Two cases occurred among the active component U.S. Army, a rate of 0.4 per 100,000 population; no case was attributable to infection acquired during deployment. Eight (80%) were foreign born. Seven (70%) were smear positive and one (10%) had multi-drug resistant TB. One (10%) case died. All (100%) of the nine remaining cases completed therapy. The median time from onset of symptoms to diagnosis was 98 days, but there was substantial variability (range 21-444). This is the first report of the cohort review methodology being applied to a military population. Most performance indicators in the U.S. Army met or approached national standards.

The rate of tuberculosis (TB) in the U.S. civilian population in 2011 was 3.4 per 100,000 population.[1] In comparison, the incidence of TB in the U.S. military has been estimated at 0.87 per 100,000 person-years.[2] Thus, the U.S. military qualifies as a low incidence population (i.e., defined as rate of less than 3.5 per 100,000 by the Centers for Disease Control and Prevention [CDC]) and is approaching the goal of TB elimination in the U.S., defined as a rate of less than one per million.[3] Low incidence populations such as the U.S. military present special challenges to TB control efforts, including loss of expertise, scarcity of clinical and laboratory facilities capable of caring for TB patients, geographic separation of cases from TB specialty care, and loss of funding and personnel dedicated to TB control; additional challenges the U.S. military faces are frequent staff turnover, deployments to TB-endemic areas, and residence in congregate settings.

The goal of the TB cohort review is to contribute towards elimination of TB as a cause of morbidity and mortality. There are several specific objectives of the review process: 1) to ensure the implementation of comprehensive case management procedures for all TB patients; 2) to improve the promptness of appropriate interventions; 3) to maintain reliability of data in the TB registry; 4) to provide immediate analysis of treatment outcomes and contact investigation efforts, measured against previous cohorts; 5) to compare program outcomes to national TB control targets; 6) to identify, track, and follow up important case management issues; 7) and to provide ongoing training and education for staff.

The cohort review process has been an essential component of TB control nationally and worldwide and has been an integral part of the approach advocated by the CDC since Dr. Karel Styblo brought the approach he previously pioneered in Tanzania to New York City in the 1990s;[4,5] however, this process has not been used in the U.S. military. The objective of this evaluation was to use the TB cohort review process to assess indicators of the quality and effectiveness of the TB control programs in the U.S. Army.

METHODS

All TB cases identified at U.S. Army installations in 2011 were included in the analysis. Cases were identified from routine surveillance reports. Further information was obtained from local public health personnel, including the results of laboratory reports, radiographs, and contact investigations. All diagnoses were verified according to CDC criteria: 1) isolation of *Mycobacterium tuberculosis* from a clinical specimen; 2) demonstration of *M. tuberculosis* complex from a clinical specimen by nucleic acid amplification test (NAAT); 3) demonstration of acid-fast bacilli in a clinical specimen when a culture has not been or cannot be obtained or is falsely negative or contaminated; or 4) meeting the clinical case criteria.[6] Definitions for contact investigations were obtained from CDC guidelines.[7]

The cohort review methods used were modified from those described previously by the CDC.[5] The TB cohort review is a systematic review of the management of patients with TB disease and their contacts. The cohort is assembled from TB cases counted over a specific period of time, usually three months. The cases are reviewed approximately six to nine months after they are identified so that outcomes, in particular completion of treatment, may be assessed.

The data collection instrument used in this evaluation was modified from that used by the New York City Board of Health, and included the following information: demographics; clinical, radiographic, and laboratory case characteristics; deployment and travel history; treatment adherence and outcomes; and contact investigation and follow-up. Cases were reviewed in detail with the assistance of case managers and public health personnel at each location. Findings were compared to indicators from national performance targets set by the CDC and U.S. national averages.[8,9]

TABLE 1. Demographic, clinical, and laboratory data characteristics of the 10 cases of tuberculosis (TB) diagnosed at U.S. Army installations in 2011

Case no.	Service	Component	Location of case	Foreign born	TST at entry into military service	Cavitary lesion on chest x-ray	Sputum smear at diagnosis[a]	Culture at diagnosis	2 month sputum smear[b]	2 month culture[c]	NAAT at diagnosis	Geno-typing	HIV status	Resistance	Treatment completed
1	Army	Active	Ft Polk, LA	Y	NEG	Y	NEG	POS	NA	Y	POS	N	NEG	N	Y
2	Army	Active	Ft Campbell, KY	N	NEG	Y	1+	POS	Y	Y	NP	N	NEG	N	Y
3	Army	Retired	Ft Sam Houston, TX	N	NEG	Y	NEG	POS	NA	N	NP	N	NEG	INH/RIF/SM	Y
4	Army	Family member	Ft Gordon, GA	Y	NA	Y	4+	POS	Y	Y	POS	N	NEG	N	Y
5	Army	Family member	Ft Gordon, GA	Y	NA	Y	1+	POS	Y	Y	POS	Y	NEG	N	Y
6	Army	Family member	Ft Gordon, GA	Y	NA	Y	4+	POS	Y	Y	NP	N	NEG	N	Y
7	Army	Family member	Ft Carson, CO	Y	NA	Y	4+	POS	Y	Y	POS	Y	NEG	N	Y
8	Army	National Guard	Ft Carson, CO	Y	POS[d]	Y	4+	POS	Y	Y	POS	Y	NEG	N	Y
9[e]	Air Force	Retired	Ft Carson, CO	Y	NEG	N	4+	POS	NA[e]	NA[e]	POS	Y	NEG	N	NA[e]
10	Navy	Family member	Tripler Army Medical Center, HI	Y	NA	N	NEG	POS	NA	Y	POS	N	NEG	INH	Y
Total (%)				8 (80%)		8 (80%)	7 (70%)	10 (100%)	6 (100%)	8 (89%)	7 (70%)	4 (40%)	0 (0%)	2 (20%)	9 (100%)

[a]Highest grade of sputum smear: refers to the number of organisms found per high powered field (1000X mag under oil immersion). This number relates to the degree of infectivity of the patient as well as to the severity of the disease.

[b]No sputum smear was expected at 2 months if the initial smears were negative

[c]Was the culture cleared at 2 months? No culture was expected at 2 months if the initial cultures were negative

[d]No quantitative results were available, only the history of a positive test was noted in medical records

[e]Case 9 died before treatment initiation and 2 month labs were drawn

TST= tuberculin skin test; NAAT=nucleic acid amplification test; INH=isoniazid; RIF=rifampin; SM=streptomycin; Y=yes; N=no; POS=positive; NEG=negative; NA=not applicable; NP=test not performed

After consolidation and analysis of the findings, the authors presented the findings for both the individual cases and the aggregate clinic outcomes to staff from the U.S. Army Public Health Command (USAPHC) and to the Chiefs of Preventive Medicine and TB nurse case managers at each location where a TB case was identified and managed. The findings, lessons learned, and recommendations for improvement was discussed with clinic staff. A summary group report card was distributed with the results from the cohort review.

RESULTS

Ten cases of TB disease were diagnosed at U.S. Army installations in 2011 **(Table 1)**. Two (20%) cases occurred among active component service members, three were retirees, and all others were family members. None of the cases were attributable to infection acquired during deployment. Eight (80%) were foreign born, and none were co-infected with HIV. All were pulmonary cases. Seven (70%) were smear positive, and all were culture positive. There were two (20%) cases of drug resistance, and one (10%) had multi-drug resistant TB. One (10%) case died. TB treatment was completed in all of the nine remaining cases (100%); directly observed therapy was used in all cases. At times of diagnosis, eight (80%) had cavitary lesions on chest imaging, and seven (70%) were smear positive, indicating greater potential for infectivity. Seven (70%) cases had a NAAT completed, and four (40%) of the cases had genotyping completed. Eight of nine (89%) had cultures repeated, and six had smears repeated, at two months (100% of those indicated).

Chronic cough was the most common symptom (90%) **(Figure 1)**; five (50%) presented with a chronic cough as their only symptom **(data not shown)**. Chronic cough was attributed to asthma in two of the cases. Median time from onset of symptoms that could be attributable to TB to presentation to health care was almost two months (range 1-142 days) **(Table 2)**. Median time from presentation to treatment initiation was 31 days (range 3-308). The median infectious period was 197 days (range 84-408).

Of the 563 contacts identified (56.3 contacts per case), 513 (91%) were located and evaluated for TB **(Table 3)**. There was one secondary active TB case (0.2%) identified among the contacts. Twenty-five (5%) of the contacts were found to have latent TB infection (LTBI) by the Tuberculin Skin Test (TST); 24 of these (96%) agreed to

FIGURE 1. Presenting symptoms among tuberculosis (TB) cases

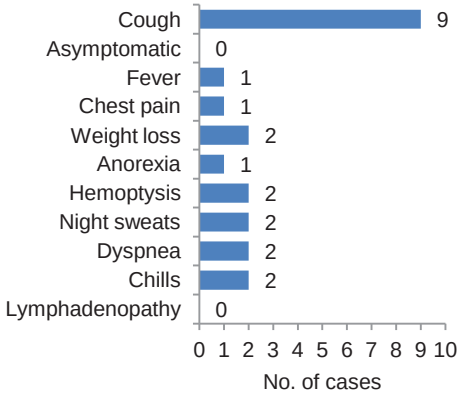

TABLE 2. Time to diagnosis and treatment (in days) among tuberculosis (TB) cases

Case	Date of symptom onset	Time from symptom onset to presentation	Time from presentation to diagnosis	Time from presentation to treatment initiation	Time from diagnosis[a] to initiation of contact investigation	Infectious period
1	2/4/2011	61	27	30	1	197
2	9/13/2011	82	46	48	0	236
3	8/1/2010	142	302	308	6	148
4	2/26/2011	59	31	31	0	165
5	4/21/2011	1	20	20	0	126
6	2/11/2011	32	4	7	0	84
7	8/1/2011	1	101	107	7	366
8	2/24/2011	90	3	3	0	199
9	3/1/2011	62	47	NA	2	197
10	2/18/2011	5	294	296	7	408
Median		60	38.5	31	0.5	197
Range		1-142	3-302	3-308	0-7	84-408

[a]Date of suspected diagnosis (symptoms compatible with diagnosis of TB)

TABLE 3. Outcomes of contact investigation among tuberculosis cases

Case	Contacts	Evaluated (%)	Infected (%)	Started treatment (%)	Completed treatment (%)	Secondary cases (%)
1	19	19 (100)	1 (5.3)	1 (100)	1 (100)	0
2	43	43 (100)	7 (16.3)	7 (100)	7 (100)	0
3	43	43 (100)	0	0	0	0
4	178	166 (93)	2 (1.2)	2 (100)	1 (50)	0
5	41	41 (100)	1 (2.4)	1 (100)	1 (100)	0
6	38	38 (100)	2 (5.3)	2 (100)	0	0
7	65	65(100)	2 (3.1)	1 (50)	0	1 (1.5)
8	89	52 (58)[a]	5 (9.6)	5 (100)	4 (80)	0
9	41	41 (100)	5 (12.2)	5 (100)	5 (100)	0
10	6	5 (83)	0	0	0	0
Total	563	513 (91)	25 (4.8)	24 (96)	19 (79)	1 (0.2)

[a]Most contacts identified were other reservists. Attempts were made to bring in these patients for evaluation without success.

initiate therapy for LTBI, of which 19 (79%) completed therapy. Eighty-two (14.6%) of all contacts were classified as high priority, and the majority of new infections (96%) came from this category. Additionally, the proportion infected was much higher among the high-priority contacts (30.5%) than among the intermediate-priority (0%) or low-priority (0.32%) contacts. The seven smear positive cases had more contacts identified (70.7 per case) than did the three smear negative cases (22.7 per case), and the former accounted for 24 of the 25 LTBI cases found (96%).

Compared to the CDC's 2015 national performance targets and U.S. national averages, the crude rate of TB disease (2 cases) in the active duty U.S. Army (0.4 per 100,000 population) was much lower than the general U.S. population **(Table 4)**. The U.S. Army met or exceeded both the U.S. average and CDC benchmark for most indicators. The U.S. Army has already met all of the 2015 national performance targets for all but two indicators: 1) genotyping and 2) contacts of sputum smear positive cases that were evaluated for infection. For only one indicator (genotyping), the U.S. Army performance was lower than the U.S. average.

EDITORIAL COMMENT

This is the first TB cohort review of experience of the U.S. military. The review demonstrates that TB treatment and control measures in the low-incidence setting of the U.S. Army compare well overall to national indicators and U.S. national averages.[8,9] Delays in TB diagnosis can be addressed in multiple ways. Epidemiologic clues can be important in identifying patients at risk for TB, and the risk factors identified in this report should be shared with medical and public health providers. Chronic cough was the most common presenting symptom in this population. Foreign born patients are also at higher risk for TB disease through reactivation of LTBI.[10] However, although provider and public health education are necessary, they are insufficient by themselves. The most important component is developing administrative policies and procedures to ensure that the diagnosis of TB is considered in all appropriate settings.[3] A useful adjunct to reduce delays is the use of NAATs. Compared to conventional culture-based methods, rapid detection using molecular methods can enable earlier initiation of effective therapy and thereby reduce periods of infectiousness of source cases.[11] It also allows for more efficient and timely identification of potential contacts and can substantially decrease the time from presentation to definitive diagnosis. For these reasons, providers should consider the use of NAATs early in the process of the diagnostic workup, and public health personnel should ensure that NAAT testing is available in all settings where the diagnosis of TB may be considered.

In a population as diverse and geographically separated as the U.S. Army, TB transmission should be closely monitored and tracked. One important method of documenting TB transmission is through the use of genotyping.[12] In this study, only one case of secondary TB disease was identified, and no other cases were epidemiologically linked. Even in such situations, the information provided by genotyping is important in confirming lack of transmission. This is especially important among soldiers who have deployed to Afghanistan or other TB-endemic areas; in evaluating such deployment veterans, genotyping can better define the very uncertain risk of infection during deployment. The CDC objectives and performance targets for 2015 specify that genotyping should be

TABLE 4. Comparison of U.S. Army 2011 tuberculosis (TB) control performance to CDC performance target and U.S. national average

Indicator	CDC performance target[9]	U.S. average[6,8]	U.S. Army, 2011[a]
Proportion of TB patients in whom 12 months or less of treatment is indicated who complete treatment within 12 months	93.0	83.2[b]	100.0
TB case rate (per 100K)	0.7	3.4	0.4[f]
Proportion with positive AFB sputum-smear results who have contacts elicited	100.0	92.3[c]	100.0
Proportion of contacts to sputum AFB smear positive TB patients who are evaluated for infection and disease	93.0	80.7[c]	90.0
Proportion of contacts of sputum AFB smear positive TB patients with newly diagnosed LTBI who start treatment	88.0	71.3[c]	96.0
Proportion of contacts with newly diagnosed LTBI who complete treatment	79.0	61.6[c]	79.0
Proportion of culture positive TB cases with initial drug susceptibility results reported	100.0	97.3[c]	100.0
Proportion of TB patients with positive AFB sputum-smear results who initiate treatment within 7 days of specimen collection to n%[e]	Undefined	Undefined	100.0
Proportion of TB patients with positive sputum culture results who have documented conversion to sputum culture-negative within 60 days of treatment	61.5	51.8[b]	89.0
Completeness of each core Report of Verified Case of Tuberculosis data item reported to CDC	99.2	Unknown	Unknown
Proportion of patients who are started on the recommended initial 4-drug regimen when suspected of having TB disease	93.4	87.2[c]	100.0
Proportion of culture-confirmed TB cases with a genotyping result reported	94.0	63.0[d]	40.0
Proportion of TB cases with positive or negative HIV test result reported	88.7	76.0[b]	100.0
Proportion of TB cases with a respiratory site of disease that have a sputum-culture result reported	95.7	91.5[c]	100.0

[a]Includes pulmonary TB only

[b]Average from 2004-2006

[c]Average from 2004-2008

[d]Average from 2005-2008

[e]Undefined by CDC: the CDC defers to specific TB Control Offices in this instance as local conditions and cases are highly variable. The metric is defined by specific TB Control Offices based on local conditions.

[f]Rate is based upon the two cases among active duty soldiers and the total number of active duty soldiers in 2011. Calculation of a rate for all 10 cases was not possible because of uncertainty about the size of the total population of family members, retirees, and Guard and Reserve who obtain care at Army medical facilities.

CDC= Centers for Disease Control and Prevention; AFB=acid fast bacilli;LBTI=latent tuberculosis infection

completed in at least 94 percent of all contact investigations.[8] In the recent experience of the U.S. Army, genotyping was completed in only 40 percent.

In this report, all smear positive source cases had contacts identified, consistent with the target set by the CDC.[8] There were 56.3 contacts identified per TB disease case. In contrast, previous reports in New York City reported only 8.2 contacts per case, or 85 percent fewer contacts per case.[4] Additionally, of all the contacts evaluated in the U.S. Army, 85 percent were classified as either intermediate or low risk. Finally, only four percent of U.S. Army contacts were found to be infected with LTBI (one low risk contact and no intermediate risk contacts); the finding suggests that a substantial amount of over testing may have occurred. CDC guidelines recommend a "concentric circle" approach, starting with the high-priority contacts and only proceeding to lower priority contacts if the risk of infection is elevated in the high-priority group.[7] The background prevalence of LTBI in the U.S. is estimated to be four percent;[13] thus, if the prevalence of LTBI in the high-priority group is four percent or less, no further testing is indicated. Only two of the cases met this criterion for expansion of testing to lower-priority contacts. Although proceeding to lower-priority contacts is a conservative approach, it unnecessarily increases the workload while creating uncertainty about the significance of positive skin test results. This is because testing of low-prevalence patients results in a high probability of having false positives,[14] and such testing has previously led to pseudoepidemics of false positive conversions in several U.S. Army populations.[15] Treatment of false positives results in no benefit to the patient, but increases risk for adverse events from LTBI therapy.[16]

Limitations in this study include misclassification of exposures and outcomes due to variability in access to data and data quality, as in previous studies.[4,17,18] The geographic distances and heterogeneous settings lead to substantial variability between sites, which may have affected both the clinical care and the data quality from site to site. Additionally, some cases may have been treated at local health departments or at private physicians' offices instead of military facilities, leading to inconsistent follow up and incomplete data acquisition. The small sample size of only 10 cases from one year limits the conclusions that can be drawn from this analysis. The results of this cohort review may not be generalizable to other populations, but should be similar to other military services and other low-incidence settings. Finally, no data are

yet available on the impact of this evaluation on TB control efforts; these should be presented in future analyses.

The TB cohort review can provide useful information in improving the TB control program in the U.S. military, as it has in other populations.[4] The U.S. military has serious challenges to TB control that are similar to other low-incidence areas, but also has the additional challenges of geographic separation, frequent staff turnover, deployments to TB-endemic areas, and residence in congregate settings. Nevertheless, this review shows that most of the indicators of TB control in the U.S. Army are quite good. The TB cohort review is an important method of assuring accountability in the U.S. Army's TB control program, and it can be used to further the program's goal of achieving TB elimination in the U.S. Army.

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Incidence of Acute Respiratory Illnesses Among Enlisted Service Members During Their First Year of Military Service: Did the 2011 Resumption of Adenovirus Vaccination of Basic Trainees Have an Effect?

This study analyzed the incidence of acute respiratory illnesses (i.e., upper respiratory illnesses, bronchitis and bronchiolitis, and pneumonias) during the first 12 months of service among enlisted members of the active components of the U.S. Armed Forces. Subjects were assigned to cohorts designated 1999 through 2012 corresponding to the years during which they entered service. The objective was to determine if the late 2011 resumption of administration of adenovirus vaccines to basic trainees was associated with a reduction in acute respiratory illnesses among the 2012 cohort. Because acute respiratory illness rates were considerably higher during the first three months than the rest of the first year of service, rates during the first three months and the next nine months of service were compared separately among the cohorts. In the 2012 cohort compared to the prior year cohorts, incidence rates of hospitalizations for pneumonia and of outpatient diagnoses of the other two acute respiratory illness types of interest were lower during the first three months but not the next nine months of enlisted service. The findings suggest a protective effect of adenovirus vaccines during recruit training. Reasons for cautious interpretation of the results are discussed.

The role of adenoviruses, particularly types 4 and 7, in causing acute febrile respiratory illnesses among trainees at military basic training (recruit training) installations has been well documented.[1,2] The early elucidation of the impact of adenovirus disease during the first few months of training for enlisted service members prompted the development of highly efficacious, oral vaccines against adenovirus types 4 and 7. These vaccines were first administered to military trainees in 1971 and were given to most trainees until mid-1999 when the only commercial supplier of the vaccines ceased their production and remaining stocks were exhausted.[1,2]

After 1999, adenovirus-associated disease returned to military basic training centers, and the need for adenovirus vaccines was again recognized.[2,3] After a prolonged, concerted effort by DoD scientists, new FDA-approved vaccines for types 4 and 7 were re-introduced to all basic training centers in October and November 2011.[4,5] The ongoing surveillance program of the Naval Health Research Center (NHRC) demonstrated an almost immediate reduction in the incidence of adenovirus-associated respiratory illness among basic trainees of all the Services, including the U.S. Coast Guard.[6] Continued NHRC surveillance has documented the persistence of this effect into 2013.

This report documents incidence rates of acute respiratory illnesses among enlisted service members who entered the Services both before and after resumption of the adenovirus vaccine program. Unlike the NHRC's trainee surveillance program that includes laboratory identification of adenoviruses and other specific pathogens, this study relied upon estimates of the incidence of acute respiratory illnesses based upon clinical diagnoses recorded in the electronic health records of enlisted service members during their first year of service.

METHODS

The surveillance period was 1 January 1997 through 31 March 2013. The study population consisted of enlisted members of the active components of the Air Force, Army, Marine Corps, Navy, and Coast Guard who 1) entered military service for the first time during the years 1997 through 2012; 2) were in the grades E-1 through E-4 during their first 12 months of service; 3) had as a first assignment one of the ten recruit training centers; and 4) completed at least three months of active duty after entering the service. Individuals who had military service prior to 1997, were members of the Reserve or National Guard, or did not complete at least three months of service were excluded. If individuals had two or more separate periods of enlisted service that began during the surveillance period, only the first period was considered during analyses.

The study population was distributed into sixteen cohorts (designated cohorts 1997 through 2012) based on the years in which they entered military service. The outcomes of interest were instances of inpatient and outpatient medical encounters for acute respiratory illnesses (ARI) during the service members' first twelve months of service. The follow-up period was divided into two separate intervals, i.e., the first three months of service and the next nine months of service (months 4-12). Most enlisted service members conduct initial military ("recruit") training during the first three months and military occupation-specific training during the next nine months of their first years of service. Military occupation-specific training is commonly, although not always, conducted at installations different from locations of service members' recruit training. After their military occupation-specific training (usually before the first years of service have

ended), most enlistees are assigned to their first permanent duty locations based on their military occupations and the needs of their service branches.

Within each of the sixteen year-of-entry-defined cohorts, the duration of each individual's military service within 12 months of entry was ascertained from personnel records contained in the Defense Medical Surveillance System (DMSS). For analysis purposes, each individual contributed from three months (the minimum length of service for inclusion in the study) to one year of person-time to his/her cohort's overall follow-up time. Overall follow-up time of each cohort was divided into two follow-up intervals: person-time during the first three months and during the remaining nine months of the first year of service. Overall and interval-specific follow-up times were used as denominators for incidence rate calculations.

The outcomes of interest were diagnoses of ARIs that are documented in administrative records of health care encounters (maintained in the DMSS). Diagnostic codes from the International Classification of Diseases–9th Revision (ICD-9) that were recorded in the first diagnostic position in service members' electronic health records were used to identify encounters for ARI. Three categories of illness were defined, based upon the ICD-9 codes: acute upper respiratory illness (URI); acute bronchitis and bronchiolitis (AB); and, pneumonia (PN) **(Table 1)**.

Incidence rules were devised to identify distinct episodes of ARI by requiring that at least 10 days without an encounter for ARI must have passed before a subsequent encounter for ARI would be counted as a new incident case of ARI. For example, a service member who received health care for ARI on days 0, 3, 7, 11, and 16 would be counted as one incident case of ARI. If that individual subsequently received care for ARI on day 29 (i.e., after a gap of 10 or more days), that event would be counted as a newly incident case. For each incident case, the type of ARI was assigned according to a descending priority of PN, AB, and URI. Moreover, hospitalizations were prioritized over outpatient encounters. In the example above, if that individual was hospitalized on day 16 for PN, then that entire episode of ARI would be regarded as one incident case of hospitalization for pneumonia. In addition to ascertaining the incidence of ARIs, the total health care burden of ARI was estimated by counting all outpatient visits and hospitalizations, subject to a limitation of one such encounter per day. Incidence rates of ARI cases and rates of all health care encounters for ARI were analyzed separately for the first three months of service and for the remaining nine months of the first year.

TABLE 1. ICD-9-CM diagnostic codes for respiratory illnesses

Acute upper respiratory illness
460 Acute nasopharyngitis (common cold)
462 Acute pharyngitis
463 Acute tonsillitis
464 Acute laryngitis and tracheitis
464.0x Acute laryngitis
464.1x Acute tracheitis
464.2x Acute laryngotracheitis
464.3x Acute epiglottitis
464.4 Croup
464.5x Supraglottitis, unspecified
465 Acute upper respiratory infections of multiple/unspecified sites
465.0 Acute laryngopharyngitis
465.8 Other multiple sites
465.9 Unspecified site
Acute bronchitis and bronchiolitis
466 Acute bronchitis and bronchiolitis
466.0 Acute bronchitis
466.1 Acute bronchiolitis
466.19 Acute bronchiolitis due to other infectious organisms
Pneumonia
480.0 Pneumonia due to adenovirus
480.9 Viral pneumonia, unspecified
485 Bronchopneumonia, organism unspec
486 Pneumonia, organism unspecified

RESULTS

During the 1997 to 2012 surveillance period, 2,563,244 individuals began recruit training. Of these, 2,384,047 (93%) completed at least three months of service (and thus were included in the analysis) and contributed 2,273,710 person-years of follow-up. Because most of those who entered in 2012 did not complete 12 months of service before 31 March 2013 (the end of the study period), the 2012 cohort only accounted for approximately 75 percent (108,471 person-years) of the average follow-up time of the preceding year-of-entry cohorts **(data not shown)**.

Reviews of initial results suggested that records of outpatient encounters were incomplete during calendar years 1997 and 1998. For this reason, analyses were restricted to the first year experiences of the 14 cohorts that entered military service during calendar years 1999 through 2012. Also, because records of health care encounters from the U.S. Coast Guard Training Center at Cape May, New Jersey, were not fully incorporated into DMSS until 2003, only the experience of Cape May trainees from 2003 through 2012 were included in analyses. After these two changes to the study plan were implemented, total follow-up time was 1,994,626 person-years **(data not shown)**.

For all year-of-entry cohorts during the entire surveillance period, incidence rates of each type of ARI were considerably higher during the first three months than the next nine months of the first year of service **(Table 2)**. For example, for acute upper respiratory illness (URI) diagnoses, the

TABLE 2. Total incidence rates (per 1,000 person-years) of respiratory illnesses for recruit cohorts, 1999-2012

	Months 1-3	Months 4-12	IRR
Outpatient Care			
Upper resp illness	1,510.0	310.5	4.9
Bronchitis/bronchiolitis	107.6	32.1	3.3
Pneumonia	116.0	19.0	6.1
Hospitalizations			
Upper resp illness	1.4	0.9	1.6
Bronchitis/bronchiolitis	0.2	0.1	3.4
Pneumonia	7.5	1.5	5.1

IRR=Incidence rate ratio

outpatient incidence rate during enlistees' first three months (1,510 per 1,000 person-years [p-yrs]) was nearly five times the rate (310 per 1,000 p-yrs) during their next nine months of service.

Incidence rates of outpatient diagnoses of acute URIs during the first three months of service were higher among those who entered service from 2004 through 2009 than those who entered earlier or later. Of note, outpatient URI diagnosis rates during the first three months sharply declined in successive cohorts from 2010 through 2012; the rate in the 2012 cohort was the lowest cohort-specific rate of the entire surveillance period **(Figure 1)**.

Incidence rates of outpatient diagnoses of acute URIs during months 4–12 were fairly stable among cohorts who entered service from 2002 through 2008, declined in successive cohorts from 2009 through 2011, and then increased in the 2012 cohort **(Figure 2)**.

Rates of hospitalizations for URIs were generally low and fluctuated slightly from cohort to cohort; the lowest rates, during both the first three months and the next nine months of service, affected the 2009 through 2012 entry cohorts **(data not shown)**.

Incidence rates of outpatient diagnoses of acute bronchitis and bronchiolitis (AB) in the first three months of service generally increased in successive cohorts from 1999 through 2003, were relatively high and stable from 2003 through 2009, and then generally declined from 2009 through 2012. The rate in the 2012 cohort was the lowest cohort-specific rate during the entire surveillance period **(Figure 3)**.

Rates of outpatient AB diagnoses during months 4–12 generally increased in successive cohorts from 1999 through 2002, were relatively high and stable in cohorts from 2002 through 2008, and then sharply declined in successive cohorts from 2009 through 2011. The rate in the 2012 cohort was slightly higher than in the 2011 cohort but lower than in any other cohort during the surveillance period **(Figure 4)**.

Because hospitalizations for AB were uncommon, rates fluctuated greatly from cohort to cohort, and no patterns were discernible **(data not shown)**.

FIGURE 1. Incidence rates of outpatient diagnoses of acute upper respiratory illness (URI), first 3 months of enlisted service, by cohort year

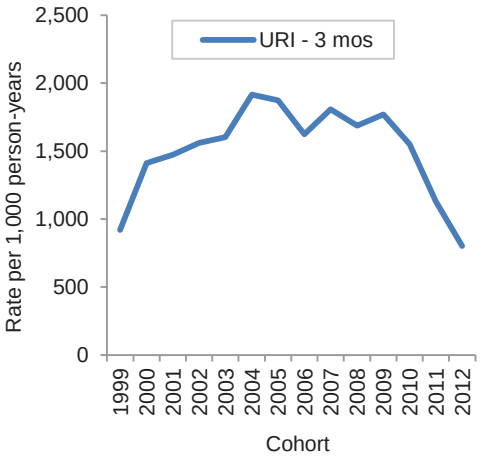

FIGURE 2. Incidence rates of outpatient diagnoses of acute upper respiratory illness (URI), months 4-12 of enlisted service, by cohort year

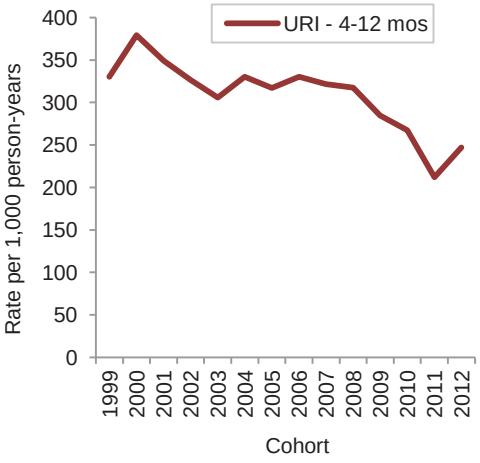

FIGURE 3. Incidence rates of outpatient diagnoses of acute bronchitis/bronchiolitis (AB), first 3 months of enlisted service, by cohort year

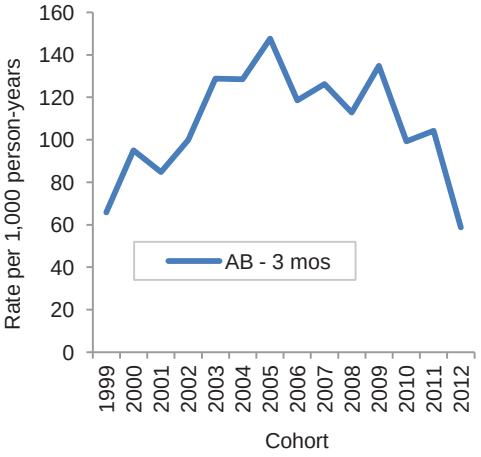

FIGURE 4. Incidence rates of outpatient diagnoses of acute bronchitis/bronchiolitis (AB), months 4-12 of enlisted service, by cohort year

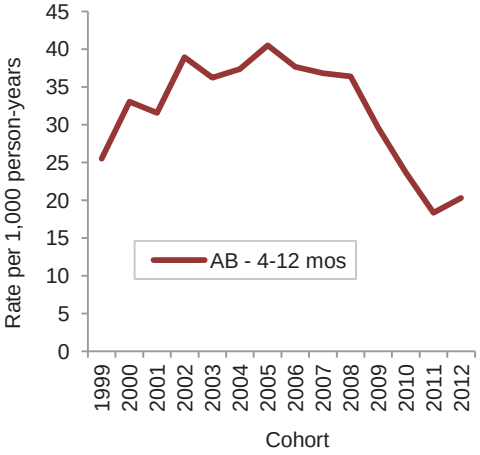

FIGURE 5. Incidence rates of hospitalization for pneumonia (PN), first 3 months of enlisted service, by cohort year

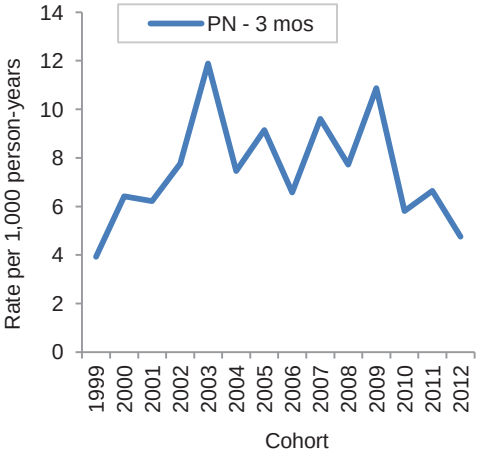

FIGURE 6. Incidence rates of hospitalization for pneumonia (PN), months 4-12 of enlisted service, by cohort year

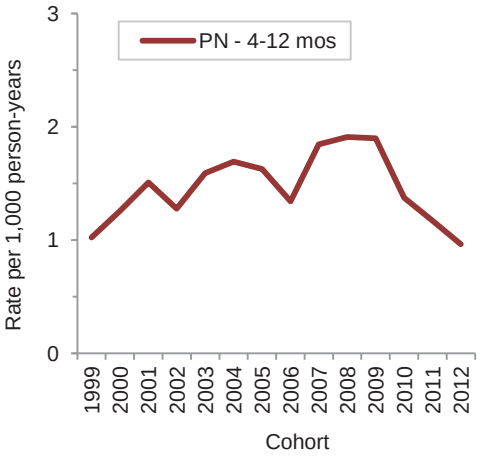

TABLE 3. Ratios of total numbers of outpatient encounters and hospitalizations to numbers of incident cases for cohorts 1999-2012

	Months 1-3			Months 4-12		
	No. encounters	No. incident cases	Ratio: encounters to cases	No. encounters	No. incident cases	Ratio: encounters to cases
Outpatient Care	1,329,885	914,423	1.45	636,327	530,586	1.20
Upper respiratory illness	1,080,216	796,480	1.36	528,791	455,523	1.16
Bronchitis/bronchiolitis	95,819	56,765	1.69	56,267	47,143	1.19
Pneumonia	153,850	61,178	2.51	51,269	27,920	1.84
Hospitalizations	4,912	4,819	1.02	3,623	3,536	1.02
Upper respiratory illness	747	741	1.01	1,319	1,303	1.01
Bronchitis/bronchiolitis	107	107	1.00	89	88	1.01
Pneumonia	4,058	3,971	1.02	2,215	2,172	1.02

Incidence rates of hospitalizations for pneumonia (PN) during the first three months of service generally increased in successive cohorts from 1999 through 2003, were relatively high and stable in cohorts from 2003 through 2009, and then generally declined in successive cohorts from 2009 through 2012. The rate in the 2012 cohort was lower than in any cohort since 1999 **(Figure 5)**. PN hospitalization rates during months 4–12 gradually increased in cohorts from 2002 through 2009, and then sharply declined in cohorts from 2009 through 2012. The rate in the 2012 cohort was the lowest cohort-specific rate of the entire period **(Figure 6)**.

Rates of outpatient diagnoses of PN during the first three months of service were higher for cohorts 2004 through 2010 but declined for the last two cohorts. During months 4–12 of the first year of service, outpatient diagnoses of PN were relatively stable, peaking in cohorts 2008 and 2009. The rate for cohort 2012 was slightly higher than that for 2011 **(data not shown)**.

In addition to enumerating incident episodes of ARIs among new enlisted service members, total numbers of medical encounters per case of ARI were estimated **(Table 3)**. In general, there were more outpatient encounters per case of PN than AB or URI. During the surveillance period, enlisted service members in their first year of service accounted for nearly 1,966,212 outpatient encounters and 8,535 hospitalizations for ARIs. Of all ARI-related outpatient encounters and hospitalizations during the first year of service, 68 percent and 58 percent, respectively, affected service members in their first three months **(Table 3)**.

EDITORIAL COMMENT

Both incidence rates of and health care encounters for ARIs overall are dramatically higher among enlisted service members during their first three months than the subsequent nine months of their first years of service. During those initial three months, the risks of acquiring an ARI are heightened due to a variety of factors including sleeping and training in congregate settings where transmission of respiratory pathogens is facilitated; young adults from a wide geographic distribution entering basic training and carrying pathogens capable of being spread to others who are immunologically susceptible to such pathogens; and, the stressful nature of recruit training. The well recognized risks of respiratory infectious diseases in the initial training environment have impelled the development and conduct of comprehensive programs to mitigate the risks. Besides the vigorous program of immunizations of new service members, other measures include careful surveillance of trainees' health, referral of ailing trainees to available health care, and liberal isolation and hospitalization of the sick.

This analysis was occasioned by the re-introduction of the adenovirus, types 4 and 7, vaccines to the initial entry trainee population in late 2011. The Naval Health Research Center (NHRC) documented in early 2012 that rates of febrile respiratory illness and the numbers of isolations of adenoviruses from trainees had fallen precipitously in the first few months after the vaccines were reintroduced.[6,7] Subsequent routine surveillance by NHRC has shown persistent dramatic reductions in surveillance indicators of adenovirus-related illnesses in trainee populations through 2012 and into early 2013. This study extends the findings of the NHRC regarding the impact of adenovirus vaccines by documenting incidence rates of ARIs among trainees before and after the vaccines' reintroduction. Unfortunately, because of incomplete outpatient records in calendar years 1997 and 1998, the analysis could not estimate ARI incidence rates during the last two years before the previous adenovirus vaccines were depleted.

The results of this study suggest a vaccine-related reduction in ARI rates in the cohort of recruits who entered service in 2012; this was the first year-of-entry cohort in which all trainees received the adenovirus vaccines. Incidence rates of outpatient URI, AB, and PN as well as hospitalizations for PN were relatively low during the

first three months of service of the 2012 cohort; however, these encouraging observations must be tempered by other considerations. First, the follow-up period for the 2012 cohort will not be completed until the end of 2013, so all relevant data are not available. Second, each of the aforementioned declines in incidence rates were preceded by relatively low rates among the 2010 and 2011 cohorts. The determinants of the relatively low ARI rates in the 2010 and 2011 cohorts likely affected the relatively favorable ARI experience of the 2012 cohort. As such, the precise effects of the adenovirus vaccines are unclear. For now, the continuing, adenovirus-specific surveillance carried out by NHRC remains the only persuasive evidence of an important and dramatic benefit after the resumption of the vaccine program among recruit trainees. In a few years, an analysis such as that conducted for this report may elucidate the natures, timing, and magnitudes of the effects of adenovirus vaccines on the broader ARI outcomes measured herein.

The ARI indicator diagnoses used as endpoints in this study are not specific to illnesses caused by adenovirus types 4 and 7, the strains present in the vaccines. Other respiratory pathogens, including other adenovirus types, influenza and parainfluenza viruses, rhinoviruses, and bacterial pathogens cause illnesses that are reported with the ARI indicator diagnoses specified as study endpoints **(Table 1)**. As a result, even a dramatic reduction in ARI incidence because of the adenovirus vaccines might be obscured by the background rates of these and other respiratory pathogens.

The results of this study do not suggest a significant impact of the resumption of adenovirus vaccine in late 2011 on ARI incidence in months 4 through 12 of enlistees' first year of service. In fact, the results suggest that incidence rates of outpatient treated ARIs in months 4–12 were slightly higher in the 2012 cohort than in preceding year-of-entry cohorts. Although the incomplete period of follow-up of the 2012 cohort may have affected these findings, the other limitations described above may be more important in masking any beneficial, late effect of the vaccine in the months following basic training. It is important to note that a lingering benefit of the vaccines beyond the initial training period for enlistees was never a goal of the initiative to reinstate the vaccine. The primary goal has been to mitigate the dramatic, occasionally fatal, impacts of these viruses on the health of new enlistees and on the operations of recruit training centers, during the crucial first few months of service to their country.[8]

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Epilepsy in Active Component Service Members, 1998-2012

Epilepsy is defined as a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures without any immediate identified cause. During the surveillance period there were 11,295 incident cases of epilepsy among active component service members (incidence rate: 52.8 per 100,000 person-years). Incidence rates increased 23 percent from 1999 to 2006, increased 52 percent from 2006 to 2010, and then decreased 38 percent from 2010 to 2012. Epilepsy incidence rates were higher among females, in the youngest age group (<20), and among white, non-Hispanics. A majority (85.8%) had no predisposing condition identified in their medical record. The number of epilepsy cases with a traumatic brain injury preceding their epilepsy diagnosis could not account for the increases in epilepsy during the period. However, the upward trend may be attributable to increased screening and evaluation of service members with possible head injuries, with subsequent detection of epileptic seizures.

Epilepsy is defined as a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures without any immediate identified cause. An epileptic seizure is a transient disruption of normal brain function due to abnormal excessive or synchronous neuronal activity in the brain.[1,2] Epileptic seizures are classified into partial (i.e., localized to one area of the brain) and generalized seizures (i.e., affecting the entire brain). The intensity of an epileptic seizure ranges from benign – no alteration of consciousness or brief absences – to severe – loss of consciousness and/or full body muscle spasm.[1,2]

The etiology of epilepsy is multifactorial and, often, the cause is unknown. Known risk factors include family history or brain insults such as head trauma, brain tumor, cerebrovascular disease, or central nervous system (CNS) infections (e.g., meningitis, encephalitis).[3] The prognosis depends on several factors including etiology, age at onset, number of seizures at onset, the natural history of the condition, and response to the use of antiepileptic drugs (AEDs).[4,5] In severe cases, epilepsy cannot be controlled by AEDs – known as intractable epilepsy – and more aggressive measures must be taken to control the seizures.

For civilian applicants to military service, Department of Defense policies and regulations allow individual consideration to applicants with epilepsy only if the applicant has been seizure-free without medication for the five years immediately prior to the application and has had recent normal electroencephalography (EEG) results.[6-10] Each Service has different policies regarding the retention of individuals who develop epilepsy while on active duty. In general, a service member diagnosed with epilepsy is assessed by a Medical Review Board which then makes recommendations ranging from no restrictions or restricted military duties and assignments (e.g., if the epilepsy is fully controlled medically) to a full medical discharge.[8,9] In select occupations, such as aviation, any seizure is immediately disqualifying.

The objectives of this analysis were to determine the incident counts, incidence rates, and trends of epilepsy in active component service members and the potential predisposing factors for epilepsy.

METHODS

The surveillance period was January 1998 through December 2012. The surveillance population included all U.S. service members of the Army, Navy, Air Force, Marine Corps, and Coast Guard who served in the active component of the Armed Forces any time during the surveillance period. Cases were identified from standardized records of all hospitalizations and outpatient medical encounters during the surveillance period in fixed (e.g., not deployed or at sea) military and nonmilitary (purchased care) medical facilities.

For surveillance purposes, a case of epilepsy was defined as 1) a hospitalization with an epilepsy ICD-9 code (ICD-9: 345.xx "epilepsy and recurrent seizures" or 649.4x "epilepsy complicating pregnancy, childbirth, or the puerperium") in the primary or secondary diagnostic position (diagnoses coded as 345.6x "infantile spasms" were excluded); or 2) two outpatient encounters with an epilepsy ICD-9 code in the primary diagnostic position. Individuals were counted as an incident case only once during the surveillance period.

If an epilepsy case (as defined above) had an encounter with ICD-9: 780.39 "other convulsions" prior to any of the case defining encounters, the date of the first "other convulsions" encounter was considered the incident date of his/her epilepsy. This determination was based on the coding practices that are standard for coding seizures and epilepsy. Epilepsy is generally coded when seizures occur on more than one occasion (e.g., after a first seizure episode generally coded by ICD-9: 780.39).[11] An individual did not qualify as an epilepsy case if his/her medical record contained only the ICD-9 code 780.39; this specific code was used only to assign the incident date.

For each epilepsy case identified, all medical records prior to the incident seizure or epilepsy event were searched to identify possible predisposing conditions for epilepsy **(Table 1)**. In order to qualify as a predisposing condition, an individual had to have one hospitalization with one of the ICD-9-CM codes of interest in any diagnostic position or two or more outpatient encounters with an ICD-9-CM of interest in the first diagnostic position. An individual could have more than one condition identified.

TABLE 1. ICD-9-CM codes for predisposing factors for epilepsy

Predisposing factors	ICD-9-CM
Traumatic brain injury	800.xx, 801.xx, 803.xx, 804.xx, 850.xx-854.xx, 310.2, 907.0, 959.01, V15.52[a]
Brain tumor	191.x, 198.3, 225.0, 237.5, V10.85,[a] V12.41[a]
Non-injury-related brain hemorrhage	430-432.x
Cerebrovascular disease	433.xx-438.xx, 997.02, V12.54[a]
Meningitis (any type)	003.21, 036.0, 049.0, 049.1, 053.0, 054.72, 072.1, 090.42, 091.81, 094.2, 098.82, 100.81, 112.83, 114.2, 115.01, 115.11, 115.91, 321.x, 013.0x, 045.xx, 047.x, 320.x, 322.x
Encephalitis (any type)	013.6, 036.1, 045.0, 049.8, 049.9, 052.0, 054.3, 055.0, 056.01, 058.2x, 066.2, 066.41, 071, 072.2, 090.41, 094.81, 130.0, 136.2, 139.0, 046.xx, 062.x, 063.x, 064.x, 323.xx
Other infectious diseases	060.x, 061, 065.x, 066.3, 084.x, 121.2, 123.1, 128.0, 647.4
Other seizures	780.31, 780.32, 780.33
Other brain disease	348.xx
Evidence of chronic alcohol abuse	291.9, 303.9x, 357.5, 425.5, 535.3x, 571.0-571.3, V11.3[a]
Personal/family history of neurologic disease	333.2, V12.49, V17.2

[a]These codes indicate a personal or family history of the predisposing factor

TABLE 2. Incident counts and incidence rates of epilepsy, active component, U.S. Armed Forces, 1998-2012

	No.	Rate[a]	IRR[b]
Total	11,295	52.8	.
Inpatient	1,862	8.7	Ref
Outpatient	9,433	44.1	5.1
Type of seizure			
Intractable epilepsy	341	1.6	Ref
Other epilepsy	5,670	26.5	16.7
Other convulsions[c]	5,284	24.7	15.5
Sex			
Male	9,082	49.7	Ref
Female	2,213	71.7	1.4
Age			
<20	1,470	92.7	2.8
20-24	4,527	65.0	2.0
25-29	2,383	51.0	1.5
30-34	1,227	38.5	1.2
35-39	951	34.6	1.0
40+	736	33.1	Ref
Race/ethnicity			
White, non-Hispanic	7,640	56.8	1.8
Black, non-Hispanic	1,871	50.3	1.6
Hispanic	935	44.0	1.4
Asian/Pacific Islander	262	32.0	1.0
American Indian/ Alaskan Native	78	31.1	Ref
Other	509	50.5	1.6
Service			
Army	5,512	72.5	1.9
Navy	2,112	40.2	1.1
Air Force	1,965	37.8	Ref
Marine Corps	1,458	53.1	1.4
Coast Guard	248	42.7	1.1
Rank			
Enlisted	10,382	58.1	2.2
Officer	913	26.1	Ref
Military occupation			
Combat-specific[d]	1,706	64.6	1.5
Armor/motortransport	658	70.0	1.6
Repair/engineering	2,799	44.5	Ref
Comm/intel	2,394	49.4	1.1
Healthcare	982	56.2	1.3
Other	2,756	56.0	1.3

[a]Rate per 100,000 person-years
[b]Incidence rate ratio
[c]These individuals were first identified as epilepsy cases (ICD-9-CM:345); this reflects their incident seizure encounter.
[d]Infantry, artillery, combat engineering

Medical evacuations from Operations Enduring Freedom (Afghanistan), Iraqi Freedom, and New Dawn (Iraq) for epilepsy were included if they had a medical encounter with an epilepsy defining ICD-9-CM code diagnosed from 5 days prior to 10 days after a reported medical evacuation from the U.S. Central Command (CENTCOM) to locations other than CENTCOM.[12] Epilepsy medical evacuations were summarized separately from the epilepsy cases identified in this report; in addition, both active and reserve component individuals were included in this calculation.

Deaths with epilepsy as underlying cause of death (UCOD) were identified from casualty records (UCOD code for epilepsy:1500). The records of these individuals were searched to identify those who had any epilepsy or seizure-related encounter in their history (i.e., other seizure or personal/family history of neurologic diseases **[Table 1]**) or had an encounter for a predisposing condition in their history.

RESULTS

During the surveillance period there were 11,295 incident cases of epilepsy among active component service members (incidence rate: 52.8 per 100,000 person-years [p-yrs]) **(Table 2)**. Incidence rates increased 23 percent from 1999 (40.1 per 100,000 p-yrs) to 2006 (49.3 per 100,000 p-yrs), increased 52 percent from 2006 to 2010 (75.1 per 100,000 p-yrs), then decreased 38 percent from 2010 to 2012 (46.5 per 100,000 p-yrs) **(Figure 1)**.

Most cases of epilepsy were diagnosed for the first time (incident event) in the outpatient setting (83.5%); the remaining 16.4 percent were identified during an inpatient hospital stay. Most incident cases of epilepsy were identified as "other" epilepsy (i.e., not intractable) or as "other" convulsions. Three percent of incident cases (n=341) were considered intractable epilepsy at the incident diagnosis **(Table 2)**.

Overall and during every year of the period, the epilepsy incidence rates were higher in females (overall: 71.7 per 100,000 p-yrs) than males (overall: 49.7 per 100,000 p-yrs) **(Table 2; Figure 1)**. Rates among females increased 21.8 percent during the period; rates among males increased 13.7 percent during the period **(Figure 1)**. Incidence rates were highest in the youngest (under 20 years of age: 92.7 per 100,000 p-yrs) and decreased with increasing age. In service members under age 20 incidence rates increased 130 percent from 1998 (63.1 per 100,000 p-yrs) to 2009 (144.5 per 100,000 p-yrs), and then decreased 56 percent from 2009 to 2012 (62.4 per 100,000 p-yrs). Similar trends (with lower rates) were demonstrated in every age category **(Figure 2)**.

Among racial/ethnic groups, incidence rates of epilepsy were highest in white, non-Hispanic service members (56.8 per 100,000 p-yrs, respectively) **(Table 2)**. Compared to their respective counterparts, rates of epilepsy were highest among service members in the Army (72.5 per 100,000 p-yrs); among enlisted service members (58.1 per 100,000 p-yrs); and

FIGURE 1. Incidence rates of epilepsy by gender, active component, U.S. Armed Forces, 1998-2012

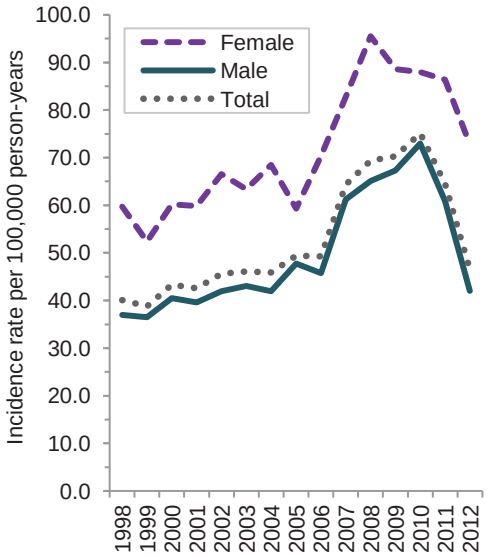


FIGURE 2. Incidence rates of epilepsy by age, active component, U.S. Armed Forces, 1998-2012

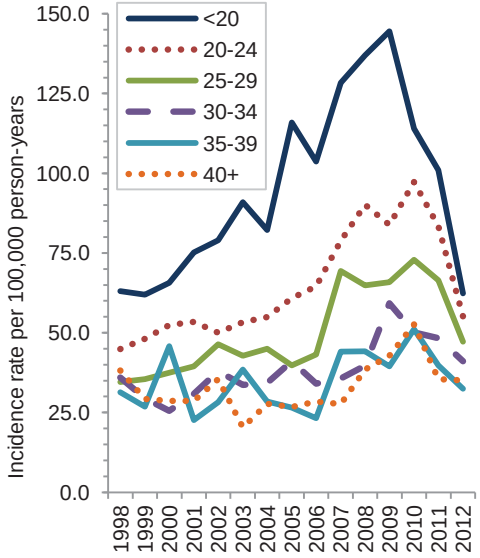


TABLE 3. Number of epilepsy cases with a predisposing condition prior to epilepsy, active component, U.S. Armed Forces, 1998-2012

Predisposing condition	No.	% total
Traumatic brain injury	875	7.8
Evidence of chronic alcohol abuse	375	3.3
Cerebrovascular disease	243	2.2
Other brain disease	198	1.8
Brain tumor	129	1.1
Noninjury-related brain hemorrhage	70	0.6
Meningitis (any type)	63	0.6
Encephalitis (any type)	31	0.3
Personal/family history of neurologic disease	28	0.3
Other seizures	11	0.1
Other infectious diseases	9	0.1
Multiple risk factors identified	322	2.9
Any risk factor (deduplicated)	1,605	14.2
No risk factor identified	9,690	85.8

among service members in "armor/motor transport" and "infantry/artillery/combat engineering" occupations (70.0 and 64.6 per 100,000 p-yrs, respectively) **(Table 2)**.

During the period the number of medical encounters, individuals affected, hospital bed days, and lost work time associated with epilepsy diagnoses increased –particularly after 2006 **(Figure 3)**. Despite a decrease in medical encounters and individuals affected in 2011 and 2012, hospital bed days and lost work time continued to increase through 2011. Overall, there were 0.8 bed days per individual affected **(data not shown)**.

Predisposing conditions for epilepsy

Of the 11,295 incident cases of epilepsy, a majority (85.8%) had no predisposing condition identified in their medical record; the remaining 14.2 percent (n=1,605) had at least one possible predisposing condition identified preceding their incident seizure/epilepsy encounter **(Table 3)**. The most common condition identified was traumatic brain injury (n=875; 7.8% total). The next most common conditions were evidence of chronic alcohol abuse (n=375) and cerebrovascular disease (n=243) which accounted for 3.3 and 2.2 percent of total cases, respectively. Each of the remaining conditions accounted for less than 2 percent of all cases **(Table 3)**.

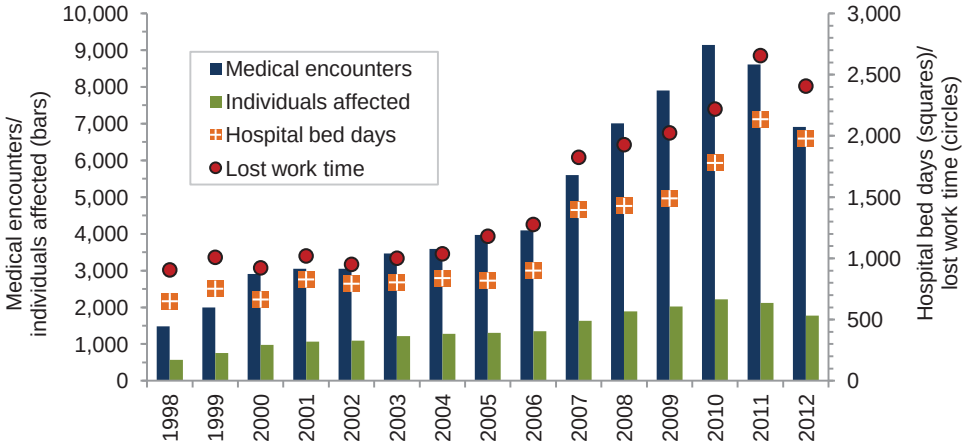
Medical evacuations from OEF/OIF/OND

From 7 October 2001 through 31 December 2012 there were 438 medical evacuations from OEF/OIF/OND (i.e., Afghanistan/Iraq) that resulted in a medical encounter for epilepsy. Nearly two-thirds of epilepsy medical evacuations (65.3%; n=286) were evacuated from OIF/OND (Iraq) **(Figure 4)**. A majority occurred in males (n=87.4%) **(data not shown)**.

Deaths from epilepsy

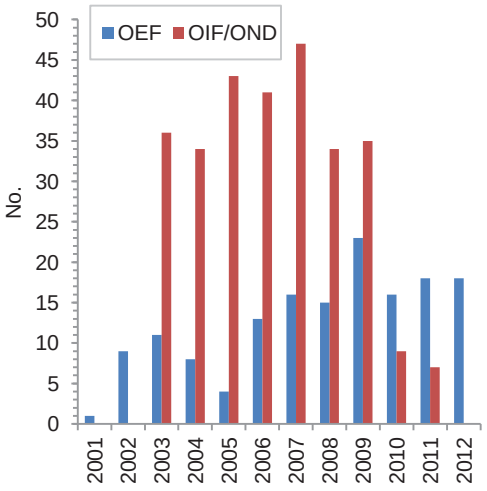
During the period there were 23 deaths with an underlying cause of death listed as epilepsy. Only one of these individuals had no documentation of an epilepsy or seizure medical encounter in his/her medical record prior to death **(data not shown)**. Of the 22 others with antecedent documentation of seizures, seven individuals had possible predisposing conditions prior to their incident epilepsy diagnosis.

FIGURE 3. Medical encounters,[a] individuals affected,[b] hospital bed days, and lost work time,[c] for epilepsy, active component, U.S. Armed Forces, 1998-2012



[a]Medical encounters: total hospitalizations + ambulatory visits for epilepsy (no more than one encounter/individual/day)
[b]Individuals with at least one hospitalizaiton or ambulatory visit for epilepsy per year
[c]A measure of lost work time due to bed days, convalescence, and one-half day for each ambulatory visit that resulted in limited duty

FIGURE 4. Number of medical evacuations from Operations Enduring Freedom (OEF), Iraqi Freedom, and New Dawn (OIF/OND) for epilepsy, active and reserve components, U.S. Armed Forces, 7 October 2001-31 December 2012



EDITORIAL COMMENT

This report summarizes the incident counts and incidence rates of epilepsy in the active components of the U.S. Armed Forces from 1998 to 2012. From 2006 to 2010 rates of incident epilepsy cases increased 52 percent. The increase was demonstrated across all demographic groups (e.g., in both males and females and in all age categories). This increase may be attributable, at least in part, to increases in moderate and severe traumatic brain injuries (prior to and during the same period) which are a well-documented predisposing factor for the development of epilepsy.[13-16] However, only 7.8 percent of all incident cases of epilepsy during the surveillance period had any documented diagnoses of traumatic brain injury prior to their first diagnosis of epilepsy. During the latter part of the surveillance period, commanders and medical personnel have given greatly increased attention to the frequency of traumatic brain injuries. In fact, in anticipation of an increase in epilepsy in service members with traumatic brain injuries, in 2008 Congress directed the Department of Veterans Affairs to establish the Epilepsy Centers of Excellence (ECoE).[17] The extent to which the screening and evaluation of service members with possible head injuries and exposures to concussive blasts have become much more thorough and commonplace may have resulted in an increased frequency of diagnoses of epilepsy.

These results should be considered in light of several limitations. This analysis relies upon ICD-9-CM coding of epilepsy in administrative data to estimate the incidence counts and rates of epilepsy. Historically, the definitions of seizures and epilepsy have been intermingled and used inconsistently.[18,19] Several iterations of the definition have been proposed, modified, and introduced by the International League Against Epilepsy (ILAE).[1,2,11,18,19] This analysis relies upon clinicians' interpretation of the definition of epilepsy which may vary based on their expertise and previous exposure to patients with seizures or epilepsy.

This report is limited to active component duty members. Moreover, some severely injured service members may receive care outside of the Military Health System (e.g., Veterans Health Administration hospitals) after they have left military service; in such cases, epilepsy – particularly posttraumatic epilepsy associated with traumatic brain injury – may not be documented on records used for this analysis.

Finally, the possible predisposing conditions identified here may or may not be actually associated with the diagnosis of epilepsy or may be part of a multifactorial process that triggered epileptic seizures. A majority (86%) of epilepsy cases do not have a predisposing condition listed in their available medical records. This finding corresponds with the observation that in most individuals with epilepsy, the etiology of their disease remains unknown.

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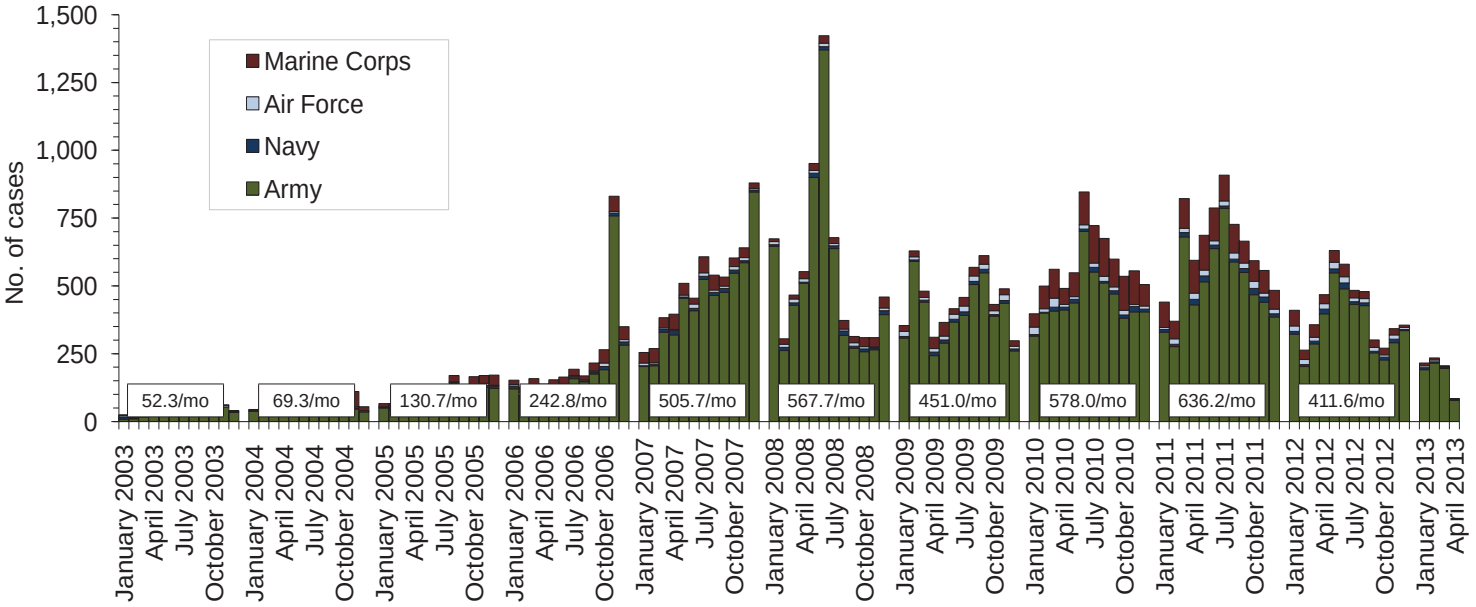
Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-April 2013 (data as of 17 May 2013)

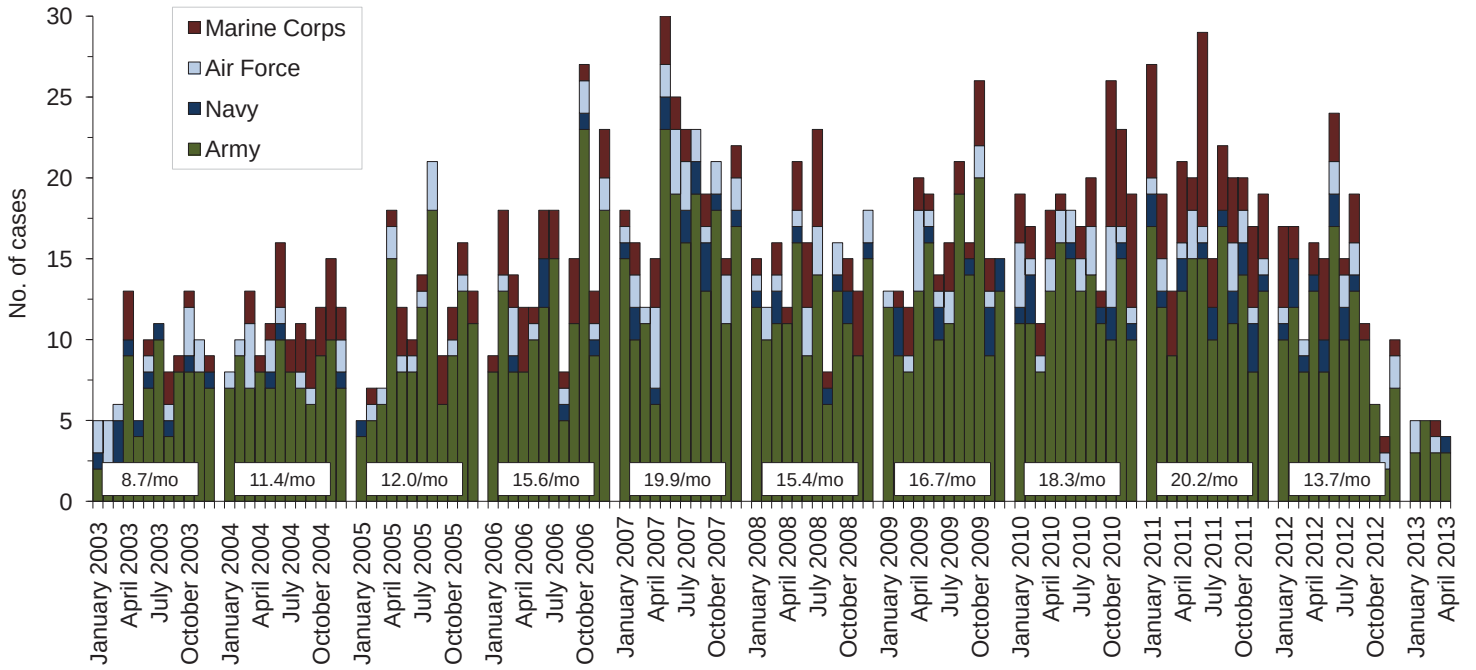
Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.52_0-9, V15.52_A-F, V15.59_1-9, V15.59_A-F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 4,120 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]



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[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from OEF/OIF.

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